THE INNOVATION CATALYST

December 2022

IN THIS ISSUE:

TECH TRANSFER TIP

with Senior Technology Manager Hossin Abdeldayem, Ph.D.:

Invite Small Business Innovation Research (SBIR) companies to license your patents free of cost and propose them to SBIR funding agencies for the sake of improving their TRL [technology readiness level] to a commercial level.

UPCOMING EVENTS:

INNOVATOR HOUR

TUESDAY, DECEMBER 13, 2022

1:00–2:00 P.M.

STRATEGIC PARTNERSHIPS OFFICE

NP-2022-11-914-GSFC

Inventor of the Month

Robots to the Rescue

According to the United Nations Office for Outer Space Affairs, there are currently 8,261 satellites orbiting the Earth. Together they play a critical role in communication, navigation, remote sensing, atmospheric monitoring, universal observations, and other tasks. They were all launched with the understanding that, if anything breaks, there is almost no way of fixing it. In some cases, the satellite just runs out of fuel. When either of those things happen, the satellite can become space junk, adding to the ever-increasing stream of debris encircling the Earth. But there's hope that robots can help to stem this flow.

So far, most repairs and construction that have been made to satellites in space have relied exclusively on astronauts. That was the case with the fixes on the Hubble Space Telescope and the construction of the International Space Station. But sending people into space each time a satellite breaks down or runs out of gas is extremely expensive and impractical; that's why there's a push to develop robots that can do the job.

"What we would really like to do," said Dr. Glen Henshaw, head of the robotics and machine learning section of the U.S. Naval Research Laboratory, "is have some way of having a robotic mechanic sent up in space that can fix satellites when they break."

Goddard's On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) project is developing the answer. Much like a service tow truck when your car breaks down, the OSAM-1 space vehicle is a robotic spacecraft equipped with the tools, technologies, and techniques needed to fix your satellite in space. During its mission, the OSAM-1 servicer will autonomously rendezvous with, grasp, repair, and refuel a satellite in orbit.

Inventor (far left) giving a tour of the Robotic Operations Center at Goddard where the OSAM-1 project is testing engineering models of the RPO and other systems necessary to perform the planned servicing on Landsat 7. Photo Credit: NASA

"When you buy a car and it gets a flat tire or it runs out of gas, what do you do" asked OSAM-1 Deputy Project Manager Emily Strube. "You go to the gas station and get more fuel, or you go to the repair shop, and you get your tire fixed. With a satellite, what they usually do is leave it on the side of the road and they go buy another one. So, OSAM-1 moves to the paradigm of trying to fix what is already up there in space."

Strube said one of the critical issues of serving a satellite in space is: how do you find it, communicate with it, capture it, and then connect with it to service

it? With the exception of the International Space Station, Strube defined most satellites and spacecraft as non-cooperative, which she said are satellites that are not naturally designed to communicate and dock with other satellites in orbit.

As SPO's Inventor of the Month, Strube designed the autonomous Rendezvous and Proximity Operations (RPO) system, which uses sensors, cameras, software, and guidance controls to help maneuver OSAM-1 to within two meters of a satellite.

"To fix a spacecraft you have to get here," explained Strube. "So, what RPO is all about is: how to bring two satellites close together. To repair it, you have to be very close together. That is what makes RPO as important to the servicing task as the robots and tools."

Strube said the OSAM-1 RPO sensor suite – which lives on the top of the OSAM-1 space vehicle – and supporting software is unique. To find and dock with a non-cooperative satellite, this RPO system contains visible and infrared cameras and a 3-D scanning Lidar. The system also contains 2-D and 3-D natural feature image recognition software applications that compute relative position and orientation between the two vehicles. Then additional guidance, navigation, and control software autonomously pilots the servicing vehicle to the client. This RPO technology is a patented technology that is available for licensing to private industry. The RPO system, which is in varying stages of flight fabrication and testing, will be flown on OSAM-1.

The first test for OSAM-1 and its RPO system is going to be the refueling of Landsat 7, which is a non-cooperative satellite. Launched in 1999, the satellite, which has observed everything from melting glaciers in Greenland, to the extent of deforestation in Papua, New Guinea, ran out of fuel in 2017 and is now slowly degrading. In the near future, NASA plans to launch OSAM-1 with its RPO system and refuel Landsat 7 to demonstrate the capability of servicing legacy satellites which were never designed to be refueled or fixed in space.

"So, in a nutshell, OSAM-1 is the tow truck used to refuel Landsat 7," said Strube. "But it needs a system to know where the satellite is located and then navigate the tow truck to exactly where the disabled spacecraft is. With this [RPO] system, using visible and infrared cameras, and laser ranging, we have all the information to tell us exactly where Landsat 7 is. Then we can move on to the reason that we are there, which is changing the flat tire or refueling the vehicle."

Artist rendering of OSAM-1 space vehicle (bottom) grappling Landsat 7 (top) during the autonomous rendezvous and docking phase of the servicing mission. Photo Credit: NASA

If the refueling of Landsat 7 is successful, Strube believes this could eventually lead to the development of better and cheaper satellites that could be serviced in space. This could even enable a new wave of in-orbit construction, with armies of robots building satellites, space stations, and even Mars-bound spaceships in space.

"What I really love about [OSAM-1 and RPO] is we are not only developing technology for other folks in industry to use, but we also showing that we can rethink how we use satellites," said Strube. "It is no more one and done; we don't have to throw away a satellite just because it broke; those days are gone. That is kind of the underlying message and RPO is one of the things [at Goddard] we do that makes it happen."

SPO to Launch Intranet Site in January

To improve communication and collaboration between the Strategic Partnerships Office (SPO) and the Goddard community, SPO is currently developing a new SPO-specific intranet site. The site is expected to launch in January 2023, with the goal to make information on technology transfer, partnerships, and Small Business Innovation Research/Small Business Technology Transfer more readily available to the Goddard community.

"One of my major thrusts for SPO is to continually identify and implement new ways to interact with the Goddard community more efficiently," said SPO Chief Darryl Mitchell. "This new site is the latest development on that front, and I am very optimistic that it will be viewed as a highly useful resource by our Goddard customers."

The SPO intranet site is being designed to be a "go-to" resource when engaging SPO staff. The new site will also help better leverage the expertise of SPO staff by allowing for the sharing of op-ed pieces, best practices on submitting a New Technology Report, and how to best partner with external collaborators.

The new visually-friendly site, with improved graphics and artwork, will also be the new landing page for SPO's monthly newsletter, The Innovation Catalyst and quarterly magazine, The Spark. Plus, it will serve as the landing site for important SPO announcements and events, such as its monthly Innovator Hour and bi-monthly Coffee Break series. These forums provide the Goddard community the opportunity interact with SPO Technology Managers and ask questions to learn more about specific topics related to technology transfer.

The SPO team hopes its new intranet site will make it easier to engage with the Goddard community and better adapt to their needs. By implementing the latest in web design, SPO is investing in providing quality website content and easy access to essential resources that will enhance visitor satisfaction.

For more information on SPO's intranet, email Rafael McFadden at rafael.j.mcfadden@nasa.gov.

THE STRATEGIC PARTNERSHIPS (SPO) OFFICE PRESENTS

INNOVATOR HOUR

Have questions about protecting your innovation?
Want to learn more about how to submit New Technology Reports?
Have general questions about technology transfer and partnerships?
Sign up for a one-on-one 20-minute timeslot with a SPO representative.
Meetings will be held virtually via Microsoft Teams.

NEXT SESSION: **TUESDAY, DECEMBER 13, 2022**
1:00-2:00 P.M.

Available Timeslots
1:00-1:20 P.M.
1:20-1:40 P.M.
1:40-2:00 P.M.

How to Sign Up

To register for the upcoming session and secure your timeslot, complete the registration form.

Innovator of the Year

Wallops Electrical Engineer Receives the IRAD Innovator of the Year Award for his Work on the Swarm

For his innovative work on developing NASA's Swarm Communications platform, Scott Hesh, an electrical engineer with the Sounding Rockets Program Office at NASA's Wallops Fight Facility, is the 2022 Internal Research and Development (IRAD) Innovator of the Year. Goddard's Office of the Chief Technologist presents the award each year to individuals who demonstrate the best in innovation.

"For his interdisciplinary leadership resulting in game-changing improvements for atmospheric and solar science capabilities, Scott Hesh deserves Goddard's Innovator of the Year Award," said Goddard's Chief Technologist Peter Hughes. "He developed a technology to [allow for a] sample [of] Earth's upper atmosphere in multiple dimensions with more accurate time and location data than was previously possible with a sounding rocket."

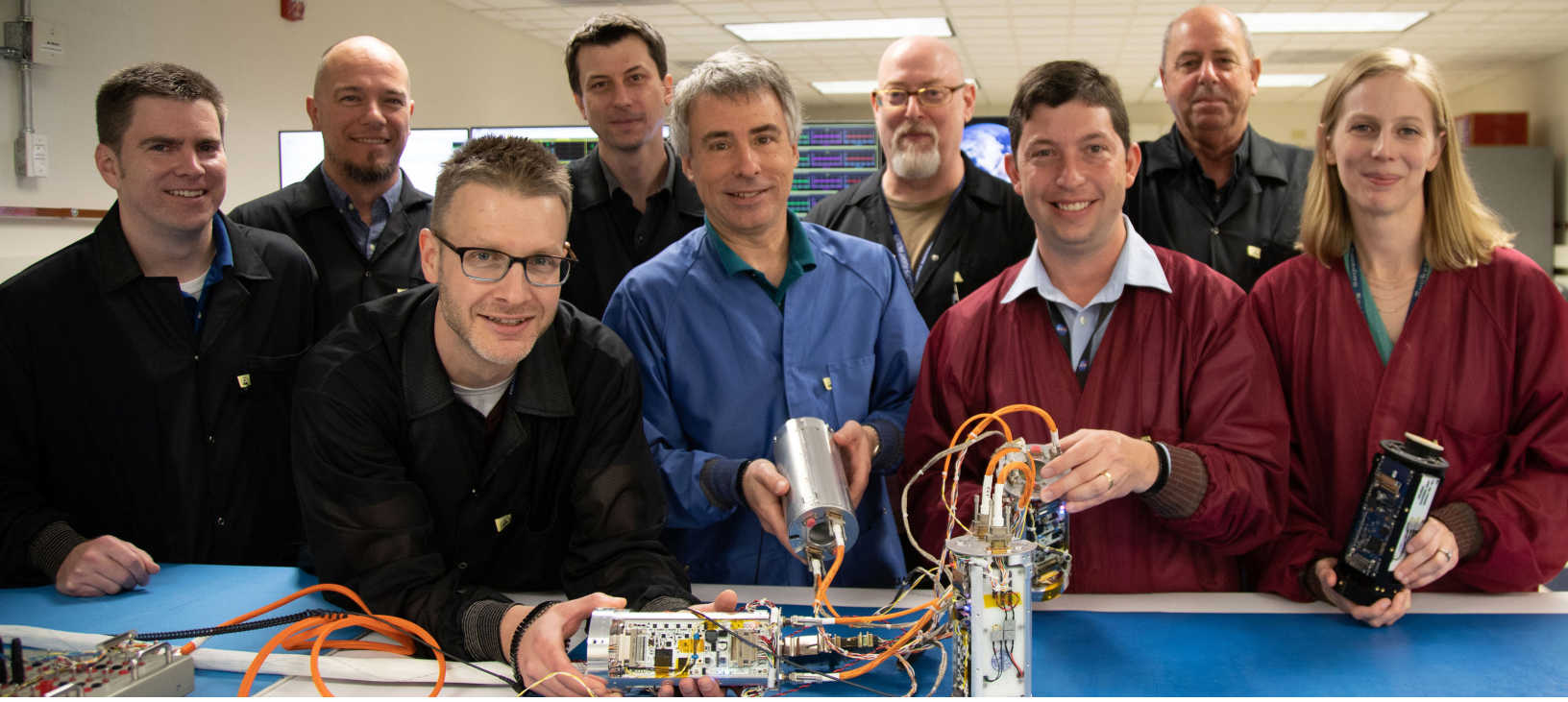
"This is a very unique and prestigious award that I am extremely honored to receive, and I am so proud of the team that accomplished this," Hesh said. "I feel a little [unfairly] singled out because a project like Swarm doesn't get done without an exceptional team. I was just lucky to be part of a team that was so dedicated to this challenge and just fun to work with every day."

Swarm Communication is a newly developed technology at Wallops that turns a single sounding rocket into a "hive" of up to 16 sub-payloads. Usually, only one science project payload goes up on each sounding rocket launch. By deploying multiple instrumented sub-payloads with Swarm on the sounding rocket, NASA will now be able to conduct numerous experiments and measurements in space on a single launch.

A sounding rocket is an instrument-carrying rocket designed to take measurements and perform scientific experiments during its sub-orbital flight. They provide an affordable platform to test new space-bound technology and conduct science experiments that cannot be accomplished on the ground.

Electrical engineer Scott Hesh works on a sub-payload cannister at NASA's Wallops Flight Facility near Chincoteague, Virginia. The cannister will be part of a science experiment and a demonstration of his Swarm Communications technology. Photo Credit: NASA's Wallops Flight Facility/Berit Bland

Hesh explained that the Swarm sub-payloads, which live on the outside of the sounding rocket, are each about the size of two soda cans stacked together. To accomplish this, there were several novel challenges he and the rest of the Swarm team had to overcome. They had to evolve and develop payload technologies that could both fit into the small space and have the right capabilities to measure Earth's upper atmosphere and perform their science mission. The effort required miniaturization of the electronics, redesign of the software and radios, and development of a custom di-pole antenna.



The Swarm Communications team displays their sub-payload cannisters at NASA's Wallops Flight Facility. In the first row (left to right), Taylor Green, Steve Bundick, and Josh Yacobucci hold three of the four swarm sub-payloads that flew on the first tech demo flight, which proved the swarm technology worked. On the right, Cathy Hesh holds a 3D-printed prototype used to develop the concept prior to building the flight hardware. In the back row (left to right) are Brian Banks, Christian Amey, Scott Hesh, Chris Lewis, and Alex Coleman (now retired). Photo Credit: NASA's Wallops Flight Facility/Berit Bland

"My primary task was to function as the embedded electrical engineer and therefore I was the natural conduit to meet this challenge," said Hesh. "By deploying these sub-payloads outside of the rocket during flight, we bring a new dimension to sounding rocket science gathering. I believe the Swarm platform gives our NASA scientists and experimenters, an unprecedented view of our world."

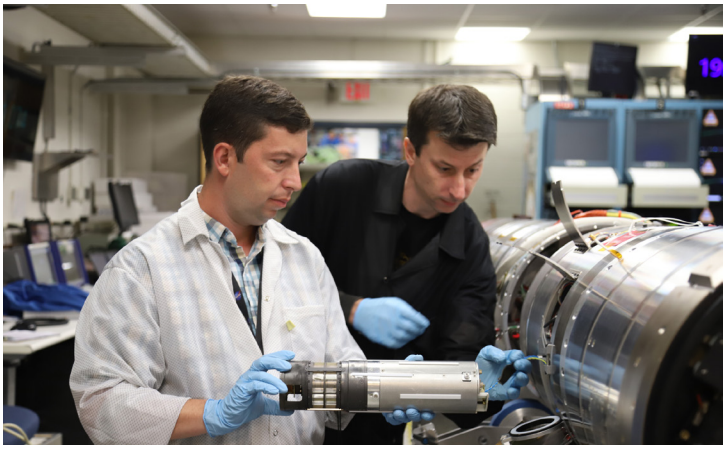
Hesh said the Swarm technology in the sub-payload cannisters offers unprecedented accuracy for monitoring and measuring Earth's atmosphere and solar weather over a wide area. The sub-payload cannisters can wonder out as far as 25 miles from the rocket. They have enough standard power and data interface to allow NASA scientists to concentrate on their experiment.

"Scott has this enthusiasm for what he does that I think is really contagious," Sounding Rocket Program Technologist Cathy Hesh said. "He's an electrical engineer by education, but he has such a grasp on other disciplines as well. So, he's sort of like a systems engineer. If he wants to improve something, he just goes out and learns all sorts of things that would be beyond the scope of his discipline."

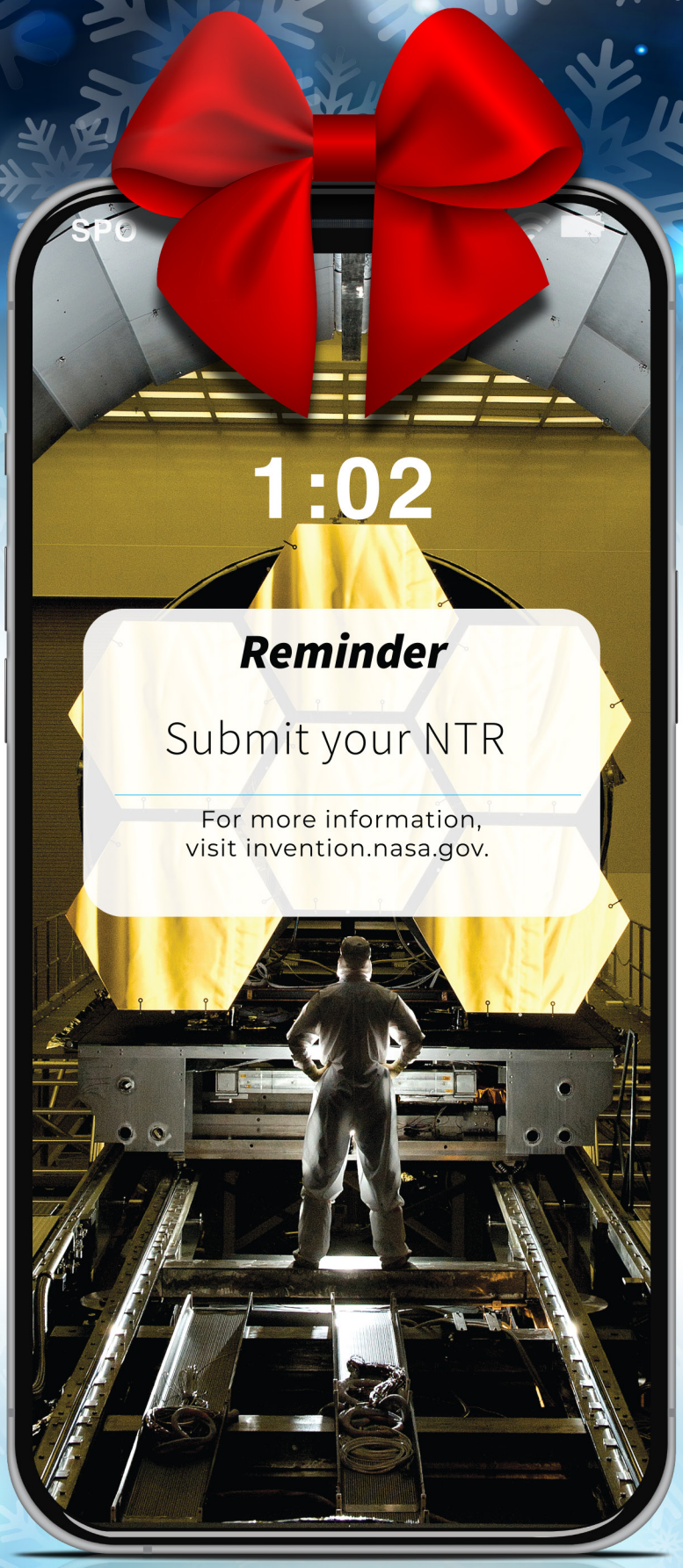
Mechanical Engineer Josh Yacobucci, who worked with Hesh for more than 15 years, said he always learns something when they collaborate. "Scott brings this great perspective," Yacobucci said. "He [often] helps winnow out things in my designs that I hadn't thought of."

Driven by interest from the NASA science community, the Swarm team was first assembled at Wallops by Cathy Hesh in 2017. Scott Hesh said, since the recent success of the test flights, there has been a huge interest from the science community in putting their instrumentation sensors on the Swarm platform. Four multiple science missions are already booked on Swarm sounding rocket launches at Wallops through mid-2024.

"It's really not that hard for [engineers] to build these sub-payloads now that we have a platform with standard data interfaces and a standardized power supply. That takes a lot of design effort off them," said Scott Hesh. "Now, we can't build these sub-payloads fast enough to keep our customers happy. That's a good problem to have."



Engineers Josh Yacobucci (left) and Scott Hesh test fit a science sensor sub-payload into a Black Brant sounding rocket at Wallops. Photo Credit: NASA's Wallops Flight Facility/Berit Bland



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